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Working with GPS

Michigan Department of Natural Resources

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GPS Overview

This page provides an overview of how GPS works. For **tips** on GPS usage, please go to our **Software Tips** page.

What is GPS?
The NAVSTAR GPS (NAVigation Satellite Timing And Ranging) Global Positioning System (GPS) is a space-based radio-navigation and time transfer system. It is an all-weather system operated by the Department of Defense and is available world-wide 24 hours a day.

Major Segments
Space Segment:
This is a constellation of up to 28 NAVSTAR GPS satellites circling the earth in six different semi-synchronous orbits at 10,900 miles (20200 kilometers) in altitude. This altitude offers minimal atmospheric drag allowing a stable orbit requiring about 12 hours. NAVSTAR satellites have precise atomic clocks and broadcast radio-frequency ranging codes and navigation data messages. The NAVSTAR constellation allows for a minimum of five satellites to be observed at all times anywhere on earth.

Control Segment:
This is the "brain" of the GPS and includes the Master Control Station (MCS), five monitoring stations, and three upload stations. The MCS, located at Falcon Air Force Base in Colorado Springs, Colorado, is responsible for tracking, monitoring, and managing NAVSTAR satellites and for updating the navigation data messages. Monitor stations, located worldwide, monitor satellite clock, and orbital parameters. Data collected at the monitor stations are linked to the MCS, where precise orbits and clock conditions, called ephemeris information, is transferred to each satellite at least once per day from an upload station.

User Segment:
This encompasses radio-navigation equipment specifically designed to receive, decode, and process the NAVSTAR satellite ranging codes and navigation messages to calculate position velocity and time. Currently, the majority of users are civilians.

For more information on GPS:

http://www.utexas.edu/depts/grg/gcraft/notes/gps/gps.html

Concept of Differential Correction

What is Differential Correction?
Differential Correction (Differential GPS, DGPS) is the process of correcting GPS positions at an unknown location in the field with data collected simultaneously at a known or surveyed location, such

as U.S. Coast Guard (USCG) beacons or Michigan Department of Natural Resources (DNR) base stations. The process of differentially correcting one receiver location relative to another can be done during post-processing in the office or in real-time in the field. The process of differentially correcting one receiver location relative to another can be done during post-processing in the office or in real-time in the field. In post-processed DGPS, the base station logs the measurements in a computer file enabling rover users to differentially correct their data upon returning to the office to indicate **where they were**. In real time DGPS, the receiver at the base station calculates error parameters for each satellite as measurements are received then transmits the corrections over a radio beacon, permitting rover users to see differentially corrected data immediately to indicated **where they are**.

How and When Do We Use Differential Correction?

Real-time GPS units have two antennas--one that receives information from satellites and one that receives information from USCG beacon signals. The receivers of these units are collecting and processing satellite and beacon information on the fly that enables the positions you are collecting to be differentially corrected and displayed during field data collection. This process will tell you **where you were** while in the field within given accuracy parameters (2-5m for Geos). Accuracy of 2-5m can be achieved with the Geo receiver, providing differential correction has been activated for the unit currently in use. Pro receivers can achieve sub-meter accuracy under the right conditions.

GPS Units at the DNR

Trimble GeoExplorer II

The Geo receiver is a pocket-sized, lightweight GIS data collection tool. You can enter the attributes of geographic points, lines, or areas while GPS positions are automatically logged. Typically, a data dictionary is required when collecting attribute information with these units, due to the limited functionality of the user interface. Data collected with the Geo can be downloaded to the PC for differential correction. The Geo unit is used in conjunction with base stations and Pathfinder Office Software to tell you where you were in the field and is ideal for mapping applications requiring accuracy of 2-5 meters.

Trimble Pro XR/XRS

The Pro receiver is a more complex GIS data collection tool combining a GPS receiver, hand held computer, and a radio receiver. The receivers are equipped with firmware (Everest Technology) that minimizes multi-path errors by detecting and screening out satellites whose signals exceed preset multi-path interference levels. Pro receivers with TDC1 or TSC1 data loggers have increased functionality over the Geo and a more complex user interface. The Pro receivers, when used in conjunction with the TDC1 or TSC1 data loggers, enhance feature collection when used with a data dictionary. In addition, they are used to tell you where you are while in the field and are ideal for mapping applications which require sub-meter accuracy.

Base Stations

DNR Base Stations (*Internal DNR Use Only*)

Locations:

Roscommon

Marquette

Other Michigan Locations:

Lansing **http://gps.msu.edu**

Correction Data:
Is collected every five seconds and posted to files in either one hour increments (Lansing and Marquette), or two hour increments (Roscommon). Lansing and Marquette base station correction files are updated continuously and posted hourly, Roscommon files, are updated continuously, posted once per day.

File naming conventions:
1 = Denotes location of the correction file, R is for Roscommon
2 = Denotes year of the correction file, 6 is 1996
3-4 = Denotes 2 digit month, 05 is for May
5-6 = Denotes 2 digit day of the month, 16 is the 16th of the month
7-8 = Denotes 2 digit hour of file based on Greenwich Mean Time, 19 is the17th-19th hours of collection data for the above day for Roscommon;19 is the 18th-19th hours for Lansing and Marquette.

Note: During Daylight Savings Time, there will be a four hour time lag between base stations and local time (e.g., the 2 digit hour of a file designated as 11 will actually be 7 a.m.). When not in Daylight Savings Time, there will be a five hour time lag.

USCG Beacon Availability and Location

Information from United State Coast Guard-DGPS Frequencies

http://www.ngs.noaa.gov/CORS/Dgps.html

Great Lakes Sites	Frequency (KHz)	Rate (BPS)	Sample Rate (Sec)	Range (Km)
Cheboygan, MI	292	200	30	177
Detroit, MI	319	200	30	161
Milwaukee, WI	297	100	30	225
Neebish Island, MI	309	200	30	97
Saginaw Bay, MI	301	100	30	136
St. Paul, MN	317	200	30	290
Sturgeon Bay, WI	322	100	30	177
Upper Keweenaw, MI	298	100	30	209
Whitefish Point, MI	318	100	30	129
Wisconsin Point, MI	296	100	30	64
Youngstown, NY	322	100	30	241